LIMITING DEVICE FUNCTION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to methods and apparatus for limiting the use of electronic devices in a certain environment or location.

Description of the Related Art

The improvements to mobile electronics devices, such as portable CD players, mobile telephones and handheld computers, has led to their widespread use without regard for the location of use. The ability of these mobile electronics devices to be taken and used almost anywhere is very convenient, but there are times and places where use of these devices is inappropriate or dangerous. Warning signs and announcements are typically used to instruct users to turn off these devices in restricted areas, but compliance with these instructions is primarily left to the user.

Examples of areas where use of mobile electronics devices is inappropriate include concert halls, movie theatres, and libraries. Examples of areas where use of mobile electronics devices is dangerous include aircraft, hospitals, and automobiles. While self policing of usage restrictions has been the primary means for limiting use of these devices, there have also been a few attempts to impose electronic restrictions on the devices themselves.

Presently, there are a few systems suitable for the very limited purpose of limiting radio wave communications. Even though some of the methods accomplish this

result through the use of interference signals of different or even stronger radio waves, none of these attempts addresses the larger problem of limiting the use of a variety of mobile electronics devices without creating secondary problems and none address restricting these devices as changes occur in the environment in which the device is operating.

Therefore, there is a need for a system, method and computer program product that allow a control system to impose usage restrictions upon mobile electronics devices that come within a broadcast range of the control system. There is also a need to impose usage restrictions at the individual feature or component level, so that other features on the same mobile electronic device that do not violate the usage restrictions can continue to be used. It would be desirable if the system automatically imposed the restrictions without relying upon user intervention or programming. It would also be desirable if the system allowed the full use of individual features to be restored automatically upon removing the mobile electronics device from the restricted environment.

SUMMARY OF THE INVENTION

The present invention provides a method for external control over operation of an electronic device having a wireless receiver. The preferred method includes broadcasting a wireless control message within a broadcast range established by a controlling system, wherein the control message includes an instruction to limit operation of one or more components within the electronic device. The instruction is received in the wireless receiver when the device is located within the broadcast range. The wireless receiver then communicates the instruction to set one or more electronic gates, wherein setting the one or more electronic gates determines whether the one or more components can be operated. Preferably, the method further includes resetting the one or more electronic gates to a default condition if the wireless

receiver has not received the instruction to limit operation within a preset time period. The electronic device may be mobile or stationary and is preferably selected from a telecommunication device such as a phone, camera, audio recorder, video recorder, pager and a computer.

In an alternative embodiment, the method comprises broadcasting a wireless control message within a broadcast range or environment established by a controlling system, wherein the control message includes an instruction to limit operation of one or more components or functions within the mobile electronic device. When the mobile electronic device is located within the designated broadcast range, the wireless receiver of the mobile electronic device receives the limiting instruction. The limiting instruction is then communicated from the wireless receiver to one or more device drivers in the mobile electronic device that operate the one or more components. Device drivers in the mobile electronic device are configured to receive commands from the operating system to specifically control a device. Commands or programming instructions that are delivered from an application program or operating system to the one or more device drivers may then be refused by the device drivers if the commands violate the limiting instructions. Application programs communicate with operating systems or device drivers, rather than communicating directly with the device.

The method may further comprise restoring full operation of the one or more components if the wireless receiver does not receive the instruction to limit operation within a preset time period. One of the components may be a power supply or other individual components or features of the wireless device. Further, the instruction may set a power level for one or more components.

The method may provide an instruction that limits operation of two or more of the components. Optionally, the instruction provides messages to two or more device

drivers, wherein the messages are selected from "enable a driver", "disable a driver", or combinations thereof. It is preferred to automatically enable each of the device drivers when the device drivers have not received a wireless control message in a preset period of time. Examples of mobile electronic devices include a mobile telephone, camera, audio recorder, video recorder, and a computer.

The present invention also provides a computer program product including instructions embodied on a computer readable medium. The instructions comprise: receiving instructions for receiving a wireless control message including operating limits for one or more components within the mobile electronic device; communicating instructions for communicating the operating limits from the wireless receiver to one or more device drivers that operate the one or more components; and refusing commands delivered to the one or more device drivers that violate the operating limits. Optionally, the computer program product will further comprise restoring instructions for restoring full operation of the one or more components if the wireless receiver does not receive the operating limits within a preset time period.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing wherein like reference numbers represent like parts of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an example of a prior art computer suitable for use in accordance with the present invention.

FIG. **2** is a schematic diagram of a prior art computer system suitable for use in accordance with the present invention.

FIG. **3** is a schematic diagram of a first embodiment of a wireless electronic device in communication with a control system.

FIG. **4** is a schematic diagram of a second embodiment of a wireless electronic device in communication with a control system.

FIG. **5** is a schematic diagram of the digital transceiver in a handheld computer receiving a control message from a control transmitter.

FIG. **6** is a schematic diagram of a PC adapter card that embodies the hardware embodiment of the present invention.

FIG. **7** is a flowchart for a method used by a control system to transmit control messages.

FIG. **8** is a flowchart for a first embodiment of a control management process for use by a handheld computer.

FIG. **9** is a flowchart for a first embodiment of a method for using an input/output device that is in communication with the handheld computer.

FIG. **10** is a flowchart for a second embodiment of a control management process for use by a handheld computer.

FIG. **11** is a flowchart for a second embodiment of a method for using an input/output device that is in communication with the handheld computer.

DETAILED DESCRIPTION

The present invention provides a system that sends wireless control messages to mobile electronic devices within a given range or environment. As the mobile electronic device is brought within the range or environment, a wireless receiver in the mobile electronic device receives the control messages and restricts the use of one or more features accordingly. For example, the control message may turn off power to the display of a mobile telephone or reduce the power level to a compact disc player.

In a software embodiment, the control message received by the electronic device is used to set status flags in a memory device within the mobile electronic device in accordance with the desired control, such as reduce a power setting. As the mobile electronic device is taken out of the range or environment, the status flags revert to a normal or previous setting. The device driver for each feature of the mobile electronic device will thus reject I/O operations that are inconsistent with the current status flags for that feature.

In a hardware embodiment, the system may receive the control message and set one or more electronically controlled latches so that the subject I/O device may not be addressed. By relying upon hardware, it is not necessary to change the device drivers to accept wireless control messages as is necessary with the software embodiment. It is preferable in either the software or hardware embodiments to have the control messages transmitted at a standard frequency that is dedicated to control messages and to design the system to prevent the user from over-riding the control messages.

The wireless control messages are transmitted from a transmitter located in the environment, region, location or facility where it is intended to limit operation of any or all of the mobile electronic devices. Examples of locations where this ability to

limit operation is useful includes, without limitation, aircraft, concert halls, libraries, and hospitals. The wireless control messages may include instructions for setting the power level of the entire mobile electronic device or setting the power levels of one or more individual features of the mobile electronic device. Examples of individual features for which it may be desirable to limit power, or otherwise control, include, without limitation, speakers, microphones, transmitters, and displays. Furthermore, these features may be included in various mobile electronic devices including, without limitation, audio and video recorders, cameras, radios, televisions, mobile phones, portable or handheld computers, and personal digital assistants. It is preferred that the transmitter broadcast the wireless control messages throughout the entire environment so that any and all of the mobile electronic devices entering the environment receive and implement the control messages. As dictated by the dimensions or contents of the environment, a plurality of transmitters may be used to broadcast the same or different control messages.

While it is possible to implement the control message as an analog signal, it is preferred to transmit the message as a digital signal. Accordingly, the mobile electronic device includes a receiver which may be implemented on a stand-alone receiver or a transmitter/receiver ("transceiver") that does not make use of the transmitter capability for the embodiments described herein.

In a software embodiment, the digital protocol for the digital message may include any existing or future wireless communications protocol, such as BLUETOOTH (a trademark of Bluetooth SIG, Inc.) which provides a short range transmission. The BLUETOOTH Protocol Architecture was developed by the Bluetooth Special Interest Group to provide specifications for different protocol stacks having a common BLUETOOTH data link and physical layer. BLUETOOTH is suitable for implementing close proximity wireless communications between devices. Interoperable application programs can be written onto the BLUETOOTH protocol

stack to provide customized usage models. While BLUETOOTH is the preferred protocol, other existing and future wireless protocols may also be implemented within the scope of the invention.

The present invention may be implemented to control electronic devices having a wireless receiver and a microprocessor controller capable of executing an operating system. When the electronic device is within proximity of a wireless control signal transmitter, one or more features or devices of the electronic device can be controlled. The electronic device receives the wireless control signals so long as the electronic device is within the range of the wireless transmissions. While much of the following discussion describes the invention as implemented to control a handheld computer, it should be recognized that the invention lends itself equally to control of other electronic devices having a wireless receiver and a processor that controls the operation of the electronic device, specifically mobile telephones. It should be recognized that the present invention may be incorporated into many other types of electronic devices as well, specifically including, without limitation, portable or handheld computers, personal digital assistants, cameras, and audio and video recorders.

As used herein, "handheld personal computer" (H/PC) means a small general computing device having a processing unit that is capable of running one or more application programs, a display, and an input mechanism that is typically something other than a full-size keyboard. The input mechanism might be a keypad, a touch-sensitive screen, a track ball, a touch-sensitive pad, a miniaturized QWERTY keyboard, or the like. The term "wireless", as used herein, shall be taken to include any communication means without wires, such as radio frequency transmissions and infrared transmissions.

FIG. **1** is an illustration of a handheld personal computer, specifically a personal digital assistant (PDA) **10**, such as the IBM WorkPad® from International Business Machines Corporation. However, the invention is compatible with other brands and types of handheld personal computers, such as a personal organizer, a palmtop computer, a computerized notepad, or the like.

Handheld computing device **10** has a casing **12** and an LCD (liquid crystal display) **14** with a touch-sensitive screen mounted in the casing **12**. A stylus **16** may be used with the device to enter data through the touchscreen display **14**. The handheld computing device **10** can also be implemented with a wireless transceiver (internal) such as an IR (infrared) transceiver and/or an RF (radio frequency) transceiver coupled to antenna **18**.

FIG. **2** is a block diagram showing the functional components of the handheld computing device **20**. It has a processor **22**, a memory **24**, a display **26**, an optional keyboard **28**, and a communications port **36** in communication with an internal system bus **25**. The memory generally includes both volatile memory **24** (e.g., RAM) and non-volatile memory **35** (e.g., ROM, PCMCIA cards, harddisk drives). An operating system **30** is resident in the memory **24** and executes on the processor **22**. The H/PC **20** preferably runs the Palm® OS operating system from Palm Computing Incorporated. However, the handheld computing device may be implemented with other operating systems, such as Windows® CE or Linux.

One or more application programs **32** are loaded into memory **24** and run on the operating system **30**. Examples of applications include email programs, scheduling programs, PIM (personal information management) programs, word processing programs, spreadsheet programs, Internet browser programs, and so forth. Device drivers **33** are also provided in memory for controlling operation of the display **26**, keyboard **28**, audio generator **38** and other I/0 devices not shown.

The H/PC **20** has a power supply **34**, which is implemented as one or more batteries or fuel cells. The power supply **34** might further include an external power source that overrides or recharges the built-in batteries, such as an AC adapter or a powered docking cradle.

FIG. **3** is a schematic diagram of a first embodiment of a computer **120** having a wireless digital receiver **128** for receiving control messages from a transmitter **130** of a control system **122**. Similar to the handheld computer of FIG. **2**, the computing device **120** has a processor **22**, an interrupt controller **23**, an internal or external memory **24**, a display device **26**, and an alphanumeric input device **28**, such as an optional keyboard. An operating system **30**, one or more applications **32**, and one or more device drivers **33** are resident in the memory **24** and executed on the processor **22**. The components of the computer **120** communicate over the internal bus **25**.

The control system **122** includes a digital transmitter or transceiver **130** and an input/output controller **132**, such as a computer, that operates the transmitter. The input/output controller **132** is responsible for managing the control messages that are broadcast by the digital transmitter.

FIG. **4** is a schematic diagram of a second embodiment of a computer **140** in wireless communication with the control system **122**. The computer **140** is substantially similar to the computer **120** of FIG. **3**, except that the digital receiver **128** is in communication with an expansion bus **126**, such as a USB or PCI bus, that is in turn in communication with the internal bus **25** through a bridge **124** rather than communicating directly with the internal bus **25**. By communicating with the expansion bus **126**, the digital receiver **128** may take the form of an adapter card.

FIG. **5** is a schematic diagram of the digital receiver **128** in the computer and the digital transmitter **130** in the control system. It can be seen from the figure that the input/output **150**, address locations **152** and data **154** are carried from the I/O controller of the control system to the FIFO buffer **158**, which sends the data on to the multiplexer **160** under the control of the bus interface controller **162**. The bus interface controller then directs information to the serializer **164**. The serializer **164** then sends information to the transmitter/driver **166** which then goes out as a wireless transmission **170**, such as radio frequency waves or infrared light.

Incoming wireless transmissions **170** enter a receiver/amplifier **172** and are deserialized in the deserializer **174**. Under the control of the bus interface controller **162**, the deserializer **174** sends the deserialized data to the demultiplexer **176**. The data then goes from the demultiplexer **176** to the FIFO buffer **178**, to be made available to the portable computer's bus. It should be noted that while the system of FIG. 5 could be implemented as software, rather than hardware, the performance might be slower. Furthermore, both the control system transmitter **130** and the portable computer receiver **128** could also be provided in the form of transceivers. The operation and use of the digital transceivers is described in U.S. Patent No. 5,877,882, which patent is hereby incorporated by reference herein. The architecture shown in FIG. 5 permits clock variation between the computer and the wireless peripheral device. Communication with devices made by different manufacturers is easily achievable since any device that conforms to the wireless link requirements can communicate with the computer.

FIG. **6** is a schematic diagram of a PC adapter card that illustrates the hardware embodiment of the present invention. The PC adapter card **50** includes a receiver **52**, a controller **54**, and an input/output device **56** that is, for purposes of illustration, capable of both read and write operations. Examples of such I/O devices would include, without limitation, memory and external CD ROM drives. The receiver **52** is

in communication with a number of gates or latches, shown here including a power latch **58**, a read latch **60**, and a write latch **62**. The receiver receives the control message and sets the latches in accordance with the control message. An example of a simple, single-frequency control message would essentially provide a series of three data bits representing the intended status of each latch. For example, a control message comprising "on", "on", and "off" would indicate to have the power "on" and the read feature "on", but the write feature "off". When the power or feature is "on", the latch would be placed in such a position or condition so that the controller is in electronic communication with the corresponding adapter card pin that will be in communication with the bus.

FIG. **7** is a flowchart for a method executed by a control system that includes a transmitter for broadcasting control messages. In state **200**, the control system specifies the features of mobile electronic devices that must be controlled in a certain environment. The features specified may be the result of a user manual input to the system or a program established by a user to specify features to control on the basis of conditions or status of the environment. In state **202**, the control system specifies the power level that the specified features may use. As with the specified features themselves, the power level specified for each feature may be the result of a user manual input to the system or a program established by a user to specify the power level on the basis of conditions or status of the environment.

After specifying the features and power levels to be controlled, state **204** provides for the control system to transmit control messages at a given frequency to mobile electronic devices having a receiver set to the same frequency. In state **206**, it is determined whether the environment has changed in a manner that would change the control message. For example, the environment in an aircraft is different during takeoff than it is during flight. If the environment has not changed in this manner, then control returns to state **204** to again transmit the same control messages. If the

environment has in fact changed, then control is passed to state **200** so that the control system can again specify the features and the power levels that should be controlled.

FIG. **8** is a flowchart for a software embodiment of a control management process for use by a mobile electronics device, such as a handheld computer. In state **210**, a receiver in the handheld computer is monitored for control messages at the control frequency. It is then determined, in state **212**, whether the receiver has detected a control message. If no control message is detected in state **212**, the state **214** provides for all current status flags to be set to their previous level and state **216** provides a wait state for a timeout period. However, if a control message is received, then, in state **218**, the control message is communicated to the wireless receiver driver. Then, in state **220**, the wireless receiver driver sets current status flags for each feature in the mobile electronics device, perhaps within individual I/O device drivers. It should also be recognized that since the control message is broadcast to a variety of types of mobile electronics devices, it is preferred for the control message to include a full set of instructions for all features that should be controlled in any device. Accordingly, mobile electronic devices without one or more features will simple ignore that portion of the message and implement only the remaining portions of the message that are application to the device. The process is repeated continuously while the mobile electronic device is turned on.

FIG. **9** is a flowchart for a method of using an input/output device that is in communication with the computer. In state **230**, an application that is being executed in the processor of the computer generates a request to use the I/O device and sends the request to the operating system. In state **232**, the operating system issues a command to the I/O device driver. Then, in state **234**, the I/O device driver inspects its associated power status flag that was set in accordance with the process in FIG. **8**. A determination is made in state **236**, whether the power status flag is set to "on". If the power status flag is not "on", then no further action is taken toward implementing

the command made upon the I/O device driver and a message is returned to the operating system **238**. However, if the power status flag is "on", then, in state **240**, the I/O device driver sends a physical I/O operation instruction to the I/O device, along with any power level limitations. This process is repeated each time an application generates an I/O request, since the power status flags may change at any time in accordance with the process in FIG. **8**.

FIG. **10** is a flowchart for a second embodiment of a power management process for use by a handheld computer. The flowchart is substantially similar to the flowchart of FIG. **8** and like numerals have been used to reference like steps. However, unlike FIG. **8**, the process involves the use of gates between the system bus and the individual I/O devices or features of the mobile electronic device. Accordingly, if the receiver does not detect a control message in state **212**, then, in state **250**, the gates to the I/O device are closed so that communication is allowed and the device is enabled. Furthermore, after communicating the instructions to the gates in state **251**, the receiver sets the gates leading from the system bus to the I/O device for each feature in the electronic device in state **252**.

FIG. **11** is a flowchart for a second embodiment of a method for using an input/output device that is in communication with the handheld computer. The flowchart is substantially similar to the flowchart of FIG. **9** and like numerals have been used to reference like steps. However, unlike FIG. **9**, the process involves the use of gates between the system bus and the individual I/O devices or features of the mobile electronic device. Accordingly, after the operating system issues a command to the I/O device driver in state **232**, the I/O device, in state **260**, sends a physical I/O operation instruction addressed to the physical I/O device. In state **262**, it is determined whether the gate is closed (I/O device enabled) from the system bus to the I/O device to which the I/O operation instruction is directed. If the gate is not closed (I/O device disabled), then no further action is taken in state **238**. If the gate is closed,

then, in state **264**, the I/O device or feature receives and executes the operation instruction. This process is repeated each time an application generates an I/O request, since the status of the gates may change at any time in accordance with the process in FIG. **10**.

It will be understood from the foregoing description that various modifications and changes may be made in the preferred embodiment of the present invention without departing from its true spirit. It is intended that this description is for purposes of illustration only and should not be construed in a limiting sense. The scope of this invention should be limited only by the language of the following claims.